manipulation of catheters across fresh suture lines.[5] In addition to the risks of transporting a sick patient, this might prolong the time to confirm or refute any outstanding surgical concerns during surgical intervention. Intraoperative angiography might be able to reduce the need for early postoperative catheterizations by alerting the surgeon to potential or actual surgical concerns in a timely fashion. The C-arm has a role in both elective and emergency cases. The counterrotation of the operating table relative to the C-arm is an additional benefit that helps in achieving optimal radiographic imaging. We currently use the catheterization laboratory team and also involve interventional cardiologists in every case requiring the C-arm.

When compared with standard imaging in the catheterization laboratory, the intraoperative C-arm suffers from lower quality of image acquisition while crowding the OR by requiring more personnel. Given the extra demand for more human resources, our initial study indicates that adoption of C-arm intraoperative angiography can change the outcome and benefit selected patients. Improved technology, as well as better device ergonomics, will optimize intraoperative angiography. However, validation of use of this technology remains difficult at present and requires more formal prospective studies.

Our initial experience with intraoperative angiography has been rewarding, with a direct effect on patient outcome. Given the continuous appreciation of known and unknown operative hazards, selective intraoperative angiography has a favorable risk/benefit profile. This imaging tool is a new addition to the practice of congenital heart surgery, with a dual role in providing objective relevant operative data while therapeutically intervening when necessary.

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Mitral and tricuspid valve repair 21 years after cardiac transplantation

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Mitral and tricuspid repair techniques have been well documented for rheumatic, myxomatous, and ischemic etiologies but have not been extensively described in the transplanted heart. With the limited pool of donor grafts available, valve repair may be a useful technique for extending the functionality and durability of the transplanted heart, especially if there is no coronary disease noted.

CLINICAL SUMMARY

A 42-year-old woman presented 21 years after orthotopic biatrial heart transplantation. She initially underwent transplantation for postpartum cardiomyopathy. She had a 6-month history of a progressive decrease in activity, weight gain, edema, orthopnea, abdominal fullness, near syncope, and palpitations. Transthoracic echocardiographic analysis showed severe tricuspid regurgitation, moderate mitral regurgitation, and biatrial enlargement in the posttransplantation heart. She had a normal ejection fraction and moderately enlarged right ventricular chamber size. Cardiac catheterization was performed and demonstrated no significant vasculopathy. Intravascular ultrasonographic analysis was not performed.

The patient underwent a redo sternotomy and was started on bypass through aortic and bicaval venous cannulation. The tricuspid valve was exposed through a right atriotomy. The chordae were intact, and the leaflets were without fenestration. The mechanism of tricuspid regurgitation was annular enlargement. The mitral valve was exposed through a transseptal approach. The leaflets were normal, and the mechanism of regurgitation was annular dilation. The mitral valve was repaired with a 28-mm Geoform rigid complete annuloplasty ring, which was downsized from her anterior leaflet size of 32 mm. The patient then underwent tricuspid

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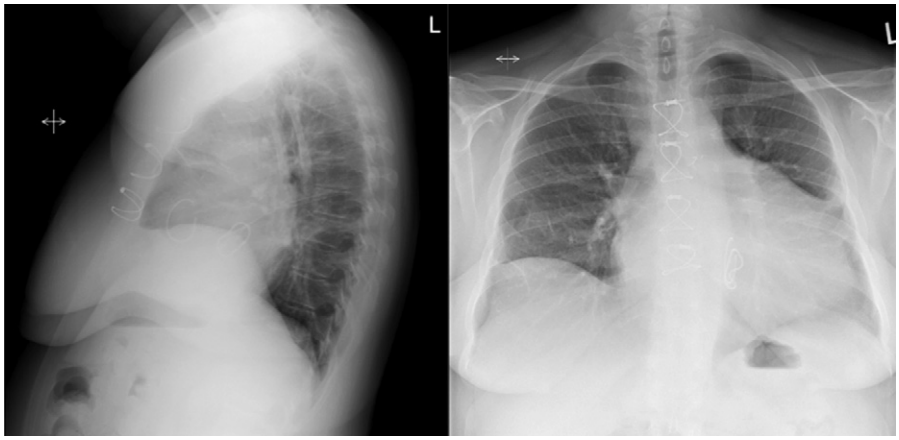

FIGURE 1. Lateral and pulmonary artery chest radiograph demonstrating double rigid annuloplasty rings in a 21-year transplanted heart. The radiograph demonstrates the complete rigid Geoform annuloplasty ring in a typical double-toroid configuration. The Carpentier classic partial rigid annuloplasty ring is seen as well.

valve repair with a 32-mm Carpentier–Edwards classic, rigid tricuspid annuloplasty ring (Figure 1). Saline testing demonstrated residual posterior leaflet prolapse of the tricuspid valve. Bicuspidization of the posterior to septal leaflet was performed to correct this, resulting in a completely competent repair without stenosis. Her symptoms have resolved completely at 6 months' follow-up, with competent valves, as shown by means of echocardiographic analysis. Furosemide has been completely discontinued. Before valve repair, she was talking 60 mg/d of a diuretic. Additionally, her lower extremity edema has resolved.

DISCUSSION

The first case of mitral valve replacement in a transplanted heart occurred 6 years after transplantation.[1] Goldstein and colleagues[2] reported the first combined mitral valve replacement and tricuspid repair in a transplanted heart. They noted mild myxomatous degenerative changes of the mitral valve from a 53-year-old donor at the time of transplantation and performed a DeVega tricuspid annuloplasty. Previous to our report, there have been 2 cases documenting double-valve repair. Wijburg and associates[3] reported both myxomatous changes and annular dilation in both the mitral and tricuspid valves in a patient 6 years after heart transplantation. They used a partial annuloplasty band to repair the mitral valve, and they sutured the septal and posterior valve leaflets to form a bicuspid valve, which was reinforced with a DeVega annuloplasty. Recently, Yoshikawa and coworkers[4] reported a case in whom a patient with endocarditis after transplantation was treated with double-valve repair.

Valve dysfunction after heart transplantation is commonplace. Early after the initial transplantation, regurgitation of the atrioventricular valves is attributable to edema and poor lymphatic drainage. Later, multiple biopsy specimens of the right ventricle can also cause tricuspid chordal or leaflet injury and subsequent tricuspid regurgitation. Donor myxomatous disease and endocarditis have also been the cause of regurgitation.[2,4,5] The biatrial anastomosis has been implicated as the cause of subsequent annular dilatation of the mitral and tricuspid valves as a result of the atrial–ventricular size mismatch. The mitral and tricuspid valve regurgitation is attributable to the long-standing atrioventricular mismatch and subsequent annular dilatation. The experience with bicaval anastomosis appears to reduce tricuspid regurgitation.[6]

This case represents the longest interval between transplantation and double-valve repair and is one of the only reports for repair with annuloplasty alone. This is the first report of double-valve, rigid, complete ring annuloplasty in the transplanted heart. Although the patient might eventually need a retransplantation, she appears to be well 6 months after her operation, with decreasing diuretic requirement and symptom improvement, as well as echocardiographic resolution of mitral and tricuspid regurgitation. Certainly her risk for retransplantation might be increased because of the valve repair, but because the heart would be completely excised, we did not believe this represented excessive risk. Valve repair appears to be a promising technique to extend the durability and improve the symptoms of patients with a transplanted heart and valvular insufficiency.

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